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# Vint Cerf on the World Wide Web

## Part II



**E.R:** Do you see laptops evolving to the point where people would use them to read books?

**Cerf:** I believe so, because I do it myself.

**E.R:** You do?

**Cerf:** I do and my wife does it today. I don't say every book I read is on the laptop. In most cases, I couldn't get it online anyway if I wanted to. But I'd point out that if I actually have sufficiently eclectic reading habits and I'm reading four or five books at a time, then carrying all of the texts in the laptop, along with all my megabytes of e-mail, is actually a lot more convenient than carrying the books around. Moreover, the font size can be adjusted instead of having to wear bifocals, and it is self-illuminating so you don't have to keep your partner awake by leaving the light on at night. So all those various things make it extremely attractive to me. I found



**V**inton Cerf is senior vice president of data architecture for MCI Engineering. Among his many accomplishments, Cerf co-developed the TCP/IP computer networking protocol widely used in the industry for communications on the Internet. Part 1 of this interview appeared in the May/June 1996 issue of *Educom Review*.

the Powerbook black-and-white laptop to be perfectly acceptable for that, and I use an IBM Thinkpad for that purpose.

And also I have to point out to you, especially when winter sets in, that most of those laptop devices have very hot batteries, and it is wonderfully comfortable to sit there reading in a slightly chilly room with a nice warm laptop in the middle of your lap. So I believe that we are at crossover—at least the first flex point of utility in reading with the laptop, and over time I think that will become more and more comfortable.

I think what you may wind up with are specific devices that act like books, that may be in addition to the PC that you are carrying around—lighter weight, physically oriented toward that, but with a significant high-resolution, high-capacity storage facility. When you go into a bookstore to buy a book, you plug it in. You stuff the book into this 200-megabyte, two-and-a-half inch cartridge and then you go on your merry way. I think that is fairly readily predictable.

**E.R:** Can you imagine that some number of years from now—maybe 25 or 50 years from now—or you pick a number—books as we know them will essentially be obsolete?

**Cerf:** I have to say yes. This is one of my few apocalyptic feelings—I think that books as a medium will become a lot less attractive if, but only if, we can assure ourselves of the reliability of these alternate media. But I think about the librarian who has been burned so many

times by microfiche and microfilm and all these other media. Do you remember 8-inch diskettes? The librarians who worry about archiving material point out that longevity is critical. And after you get done having a discussion about CD-ROM technology with a dedicated librarian in a research or archival library it stops you and makes you think a little bit. You need to have had the experience I've had—of being confronted by the librarian who excuses herself and then comes back with a one-thousand-year-old vellum manuscript which still looks as beautiful and clear as it was when it was first prepared, and says, smiling to you, now tell me a little more about the longevity of this CD-ROM thing you are excited about!

On the other hand, I do have to point out that right now newsprint is becoming so expensive—it went up in price something like 50 to 70 percent this year—that it is actually having a deleterious effect on newspapers. Now that doesn't necessarily spell the demise of books—and if anything we are publishing more now than we ever did before—but as I look at my pile of books and realize that when I am away from them I can't get to them, the attraction of being able to get to my books online is very appealing. It's so appealing that even if books don't go away I think they will surely be joined by technological alternatives—and the book publishing business will find itself with this other medium. Eventually books will be a less attractive and perhaps special-case choice.

Now I could be quite completely wrong about this, but I think that the ultimate dominance of computer-based technology is so likely that—maybe not in 50 years, but maybe in 100 years—we will eventually conclude that books are not the most cost-effective way to go. For one thing, the computer can't read them and help you find anything in them.

**E.R:** Do you think that the experiments by publishing companies, particularly newspapers, will pay off in the intermediate range?

**Cerf:** Well, I think so, although I have to point out a couple of practical problems. One of them has to do with the availability of power, the convenience of communications, and the physical characteristics of the reading devices. Think about what you do when you read the newspaper. If you are sitting at the breakfast table, the paper doesn't weigh very much and you sort of hold it up while you are eating your breakfast. Laptops today are not the same weight as a newspaper and you have to find room on the table for them. Moreover you can tear the newspaper into different sections and hand them out to everybody who wants to read the funnies while you are reading the sports section. Everybody has to have his own laptop in order to read different pieces of the newspaper. And so the dynamics are different. The physical facilities are different. Perhaps when we get tabletops that have flat panels, that will change, but in the meantime you can see that paper is still extremely attractive for certain cases.

And yet I see the computer-based stuff making some serious inroads as they have with me. I will preferentially carry an online book—assuming I can find it—to carrying a physical book around when I'm on travel.

**E.R.:** What have you read online?

**Cerf:** Well, the first experiment I did was with *Jurassic Park*, and that was about two years ago on the Powerbook 140 from Apple. That particular book was published by Voyager Press, and it had some gimmicks: if you clicked on one of the names of the dinosaurs, it would roar at you and then show you a picture of the dinosaur. You could also type in little notes and things like that. I didn't find any of those particularly attractive. I just found it nice not to have to carry the damn book around. I had to carry the laptop anyway. So I read that.

I read all of Arthur Conan Doyle. My wife downloaded Henry James's *The American* just recently, and loaded all of Shakespeare in. And, gosh, the Gutenberg Press project—if you're familiar

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with that—has released maybe 150 works. Of course that's a pittance compared to what's been published in the other media, but it's a start.

And, second, I think that as publish-

ers start to believe that there is an infrastructure out there that they can use to build their business on, they will begin to come out with online volumes that you can download.

**E.R.:** The publishers continue to be concerned about copyright issues. What are your thoughts about copyright and the Internet?

**Cerf:** Well, plainly, copyright is an important matter—or intellectual property rights in general. If you recall, the purpose behind the original copyright legislation shows up in our own founding documents as an attempt to encourage the sharing of information, supplying means to cause people to create intellectual property and then share it. That's what patent laws are for and that's what copyright laws are for. And plainly this is going to be a matter of law, in that to preserve people's incentives for producing intellectual property there have to be ways of combating infringement. So I think the government has a regulatory and/or legislative role in dealing with intellectual property.

I think the technology plays an equally important role there in providing a protective device for intellectual property, but I would observe that the most effective combination that I have seen in public so far has been the Software Publishers Association, combined with our own existing copyright laws. The SPA maintains—apparently—squads of people who look for infringements and advise people when they discover them, tell them that they are infringing and that they will be prosecuted if they don't cease and desist. And that is a very effective combination,

made potent by the fact that there are laws protecting intellectual property rights.

Some people have an apocalyptic view that the Internet will somehow destroy the notion of copyrights. I don't think that is a warranted conclusion.

**E.R.:** What about persons who suggest that it *should* destroy the notion of copyright, and who use the popular slogan "Information Needs to Be Free"?

**Cerf:** Well, I don't buy that, because I believe that such an argument will finally erode people's motives for spending time and energy and perhaps real money on the production of intellectual property. So I reject that as an unworkable outcome.

I think that there may be different ideas pursued for how one compensates a person with intellectual property rights. Of course there is debate now over the Lehman Committee report on the treatment of transmissions on the Internet. Some people who think that the Lehman Committee proposal to regard each transmission on the Net as a copy is somehow a bad idea. I don't agree with this. For one thing, the fact that you own a copyright does not mean that you therefore have to insist on payment for every copy that's made. It merely gives you the privilege of negotiating terms and conditions under which copies are made. And it seems to me that examples of these are site licenses—where one says, in the case of software, I am prepared to grant you an unlimited right to reproduce the software so long as it is confined to this particular geographic location or this particular institution.

**E.R.:** At the option of the owner of the intellectual property?

**Cerf:** That's right. I'm saying that's another alternative to copy-by-copy charging, and what I'm trying to say here

is that just because you choose to treat, legally, the transmission of an instance of a book over the Internet or a page-by-page transmission as copies of those pages, that this doesn't necessarily destroy the Internet. I think the idea here is to give as much room as possible to the owner of the copyright to negotiate terms and conditions under which copies are made—including free. There is nothing wrong with somebody saying, "There is a whole community out there for whom I am charging nothing to use this material, as long as it is not used in commerce."

**E.R.:** And you believe the decision to make it free or to make it a site license or to charge for individual copies remains with the owner?

**Cerf:** Yes, that's where I think it should stay. I think that is the only reasonable way of providing incentives for people to produce this material. And so I categorically argue that to say that just because you put it on the Internet it has to be free is a terrible miscarriage of sensibility.

**E.R.:** As we put all this stuff on the Net, one wonders just how far bandwidth can be pushed?

**Cerf:** Well, I'm not terribly worried about the underlying basic bandwidth availability, at least domestically. The fiber capacity has not even been nearly exploited yet. We already know we're doing better than the standard 2.5 gigabit telephone fibers—we (MCI) are running 3.7 now, we expect to run 9.6 gigabits in the near future. Tests have already been made at 80 gigabits per second, and there have even been 100 gigabits per second demonstrations in the lab. The native bandwidth of the fiber is 38,000 terahertz, which means that there's just enormous amounts of potential capac-

ity. So I don't think we will reach the limit any time soon.

The problem of course is not just pushing bits through fibers, it's switching them. The ability to carry increasingly large volumes in packet traffic is a big challenge. When you look at the existing Internet with its fairly thin infrastructure compared to the voice network, certainly you have to be worried about available capacity, especially as people begin pressing realtime services on the system, whether that's multicasting, video or realtime audio or teleconferencing or some of the realtime multiuser games.

I do believe that if there is an economic justification for expanding capacity—which is why I'm so interested in successful businesses being built on the Net—if there is such an economic incentive, that capacity is there and can be expanded. There is a challenge for the engineers who are building routers to figure out how to make them run a lot faster than they do now, but fortunately they are riding a computing curve which is also getting faster. There is a doubling of speed parameters and capacity parameters every 18 or 24 months that's still with us and projectable at least through the end of the decade if not somewhat beyond that.

**E.R.:** What's MCI's strategy for solving these problems and how does it differ from others?

**Cerf:** Well, MCI has chosen to go down several paths in the Internet environment or data networking in general. First of all, we believe that there is great value in content and therefore we have chosen to enter into businesses whose economics have to do with the value of con-

tent, not really just moving the books and packaging them.

**E.R.:** And an example would be?

**Cerf:** Well, a two-billion-dollar investment in News Corp. is the most prominent example of our interest in obtaining content and making it accessible in various

*"To say that just because you put it on the Internet it has to be free is a terrible miscarriage of sensibility."*

forms, not exclusively on the Internet but in other ways as well. The second thing I would observe is that the company has been very active in applied research work in high-speed networking. We were among the first to participate in the gigabit network research program that ARPA and NSF and CNRI put together way back in '88. We participated in the expansion of Internet capacity to 45 megabits with the NSF network. We won the Very Broad Band Network Service cooperative agreement from NSF. We are operating a 155 megabits per second Internet ATM service for NSF now.

We are actively involved with many of the different switch vendors—Cisco and Bay Networks, to name two—in increasing the capacity of their systems for Internet and frame relay services—to say nothing of

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having been leaders in the development of SONET optical fiber technology and very rapid adaptors of higher and higher speed fiber electro-optics for our own major backbone services. We went from 2.5 to 3.7 gigabits on our fiber simply to increase our base capacity. So we've been pursuing what I would call almost an applied research program in order to stay as far ahead as we can and to be as involved as possible with the development of the new technology.

**E.R.:** How do you think the cable companies figure in the picture?

**Cerf:** I think cable companies have a pretty good shot at providing high-speed local access. In fact, as a cable user I look forward to the day when I can have a 10 megabit emulated Ethernet access to the Internet. I expect that the cable companies ultimately will have to plug into the rest of the Internet and we will be happy to supply them with access to the rest of the global Internet with high-speed interconnects from their head-end. So that is one attraction.

There are actually some other interesting possibilities as well, because even within the standard television transmission format it is possible to encode data within the television image. You see that with closed captioning. And now there's some direct data transmission, called "InterCast," which does the same sort of thing as closed captioning except it uses more of the vertical blanking interval line to transmit data integrated in with the video. And so what could happen is that you could be watching the television pro-

gram on a standard receiver but split off that signal and analyze it and pull out the digital transmission in the vertical blanking interval to carry ancillary information. So at the same time you are getting a news report on television you may be getting the text of the more in-depth study.

Wouldn't that be interesting—you would end up almost integrating together the newspaper depth with the television instant hit.

**E.R.:** Do you see mainly winners in all this, or are there going to be some losers—industries or populations or people or whatever?

**Cerf:** Well, I think there is always the potential for losers; and there's always the potential for someone to come along you didn't know about who suddenly becomes a winner. The potential losers, I think, are the ones who fail to recognize how critical computer communications have become and fail to adapt to providing products and services in computer-mediated form. I think that they may very well find themselves with a shrinking share of the business.

**E.R.:** Who would that be?

**Cerf:** Well, I could imagine a cable company that fails completely to understand that computer services are increasingly important may find themselves in some trouble, but only if there's competition obviously. But there will be an absolute clamor. What will happen is, if cable access to the Internet becomes very

attractive and effective and your cable company doesn't do it, there's going to be a great hue and cry to the local administration that handed the franchise out to either get those guys off their butts or go get somebody else that knows what they're doing. So that's one example of it.

The local exchange carriers, I think, will be under some pressure as a consequence of that to do a better job of supplying data services. And wherever there's an opportunity to induce competition so that people who fail to get the word are superseded by people who've figured it out, the public will benefit.

**E.R.:** What kind of impact will information technology in the age of the Internet have on education?

**Cerf:** Well, it has already done something pretty dramatic as far as I can tell in many of the scientific disciplines. It is almost impossible to do a good job of research now without being on the Net and able to read, and coordinate your work with the work of others, and find out about recent events. And as Web pages get more elaborate and more easily accessible—you can imagine e-mail messages that point to Web pages and you just click on them and you are in the middle of somebody's recent research report. So I believe we already have rounded the curve in higher education on the research side.

On the curricular side I think we're still in the early days. One of the things that excites me in the K-12 area is the use of simulated environments, creating classrooms that have facilities in them that we might not ever be able to build in the real world. I'm thinking about even something as simple-minded as the text simulation world of MOOs; even in that very crude kind of environment where commands have to be typed in and you don't really see anything—you only get to talk about it—in those envi-

ronments you can create some pretty interesting learning possibilities, especially if you can mix a little bit more technology in. For example, the Cyberian city thing up at MIT has always attracted me as an interesting prototype. It's a simulated earth station in orbit around the earth and it contains a lot of different rooms to devote to various scientific activities. And one of them is an observatory. They don't do this—but I can easily imagine taking that idea and allowing students to conduct experiments using the telescopes which appear to be just a part of the simulated environment but which in fact are real instruments on the Internet and which are responding to requests to capture images or radio information from various parts of the sky.

The thing that excites me about the simulated environments—whether they are virtual reality and 3D-rendered or just simply textual—is that I can organize real-world network-based resources to be accessible through this simulated environment. And so there is a smooth and seamless linkage between the real world and the simulated world. So I guess the simple way of saying it is you can let students *do* science instead of reading about it.

Those simulated environments, of course, can be applied to more than just scientific research. We can create social environments in them and let people act out various scenarios. We can then go back and analyze them and discuss them. I saw some very interesting work being done at Simon Fraser University up in British Columbia just a couple of days ago—a demonstration by one of the professors there who showed a very interesting tool for letting students create a problem to solve—in this case it was the design of the university after the year 2000 and to create roles. One person was an anthropology professor. Another person was a PTA president. A third person was a teacher . . . and so on. And they

organized this week or two of debate and discussion, to try to get recommendations put together for the person who was pretending to be the Minister of Education. And the system that had been built, which I think was Macintosh-based, captured an enormous amount of information. All the e-mail, of course, was stashed away in an archive. It kept track of who it was that sent it, when it was sent, where were they when they sent it, which machine were they on. Of course all of these statistics were then used to go back and analyze what the interactions were about, how conclusions were reached, how people made use of the systems, and at what times of the day.

And so, talk about critical thinking! This gave the students a substantial tool set to go and find out how they worked with each other. Not only did they tackle the actual problem, but then they got to go back and understand the dynamics of group interaction. The woman who did this work is Linda Harasim, at Simon Fraser University.

**E.R:** Well, let's end with a flourish. What's your greatest fear—and what's your greatest hope—for the Internet?

**Cerf:** Well, the worst fear of course is that enormous investments will be made and the Net really will proliferate but that somehow or other—like television before it, it will be economically viable only in such a limited mode that it doesn't fulfill any of the optimistic promises that everyone has for any new telecommunications infrastructure that comes along.

*"The biggest hope is that the Internet really will succeed in becoming an infrastructure that will support and absorb all the other media that we've developed over the last couple of thousand years."*

I feel myself much on the same precipice that I imagine those people who developed television might have found themselves staring at. Or maybe only in retrospect—realizing that they were at the edge, which is the difference between the great mountain that they hoped we could walk up to find ourselves in the light, versus the great abyss where we ended up in much of television, which is just uniform pabulum that hasn't got much intellectual content. It would be a tragedy if the Internet were to end up looking into the same kind of abyss.

The biggest hope is that the Internet really will succeed in becoming an infrastructure that will support and absorb all the other media that we've developed over the last couple of thousand years. I don't mean replace, I just mean absorb and be able to provide an alternative to paper, radio, television and telephone.

And I hope that everyone in this entire planet gets access to it. It's always been my personal objective to take the Internet where no Net has gone before. ■